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MANSONIA INDUBITANS DYAR AND SHANNON—A NEW MOSQUITO ADDITION TO THE UNITED STATES FAUNA

HARRY D. PRATT, P.A. Sanitarian (R)
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Mansonia indubitans Dyar and Shannon was originally described (3) in 1925 from females collected in several localities in central Brazil and later from ma'es and females from central Brazil and Iquitos, Peru, by Shannon (5). Tulloch (6) first described the larvae and pupae from specimens found attached to the roots of **Pistia Stratiotes** Linnaeus in Lake Cartagena, Puerto Rico, on November 16 and 22, 1935. He was able to rear an adult male which is now in the United States National Museum.

Since that time males and females have been found by the writer in light trap collections at Fort Buchanan and Camp Tortuguero, P. R., chiefly in the winter months. The maximum collection contained 3 males and 36 females and was made on the night of November 29, 1942 at Fort Buchanan, P. R.

In 1943, 1944, and 1945 adult females were collected in light traps in South Clarendon Parish, Jamaica, B. W. I., by C. E. Peres, A. E. Pritchard, G. A. Thompson, and the writer. On January 17, 1945, G. A. Thompson and H. D. Pratt also collected larvae and pupae attached to the roots of **Pistia** in this same locality.

D. G. Denning, and W. W. Wirth of the U. S. Public Health Service collected larvae, pupae and reared adults from the roots of **Pistia Stratiotes** Linnaeus in Boca Raton, Florida, August 16, 1944. These specimens sent to the writer are the first definitely identified specimens of **Mansonia indubitans** Dyar and Shannon known to occur naturally in the United States.

The larvae and pupae of **Mansonia flaveolus** (Coquillett) illustrated and mentioned in the keys were collected at Carolina, P. R., September 19, 1943 on the roots of water spoon (**Hydromystria stolonifera** G. F. W. Meyer.)

As pointed out by Shannon (5), the adults of **Mansonia indubitans** Dyar and Shannon and **Mansonia titillans** (Walker) are very similar. The characters of length of female palpi and male genitalia used by Shannon appear to be valid, but are so slight as to make these determinations difficult. On the other hand perfectly good characters do exist for the separation of females using characters of female terminalia or, more specifically, of the arrangement of spines on the eighth tergite.

The genus **Mansonia** Blanchard is composed of four subgenera according to Edwards (4). In two of these subgenera: **Coquillettidia** Dyar and **Rhyn-**

chotaenia Brethes there are no spines on the eighth tergite and separation of the species on the basis of female terminalia is difficult. In the other two subgenera: **Mansonia** Blanchard and **Mansonioides** Theobald the eighth tergite is armed with sharp, heavily sclerotized hooks or spines which have a characteristic arrangement for each species. The arrangement of the spines has been shown for species in the Oriental subgenus **Mansonioides** by a number of workers including Barraud (1). The arrangement of spines on the eighth tergite for three Caribbean species: **flaveolus** (Coquillett), **indubitans** Dyar and Shannon, and **titillans** (Walker) is shown in figures 4, 5, and 6. The three species may be separated by the following key:

Key to Females using Characters of Eighth Tergite

1. Eighth tergite without a group of closely set spines in middle of posterior margin, spines separated by at least their own diameter, and arranged more or less in two irregular rows, fig. 6 ..... **indubitans** Dyar and Shannon

   Eighth tergite with a group of six to nine closely set spines in middle of posterior margin 2

2. Six spines set closely to one another in middle of posterior margin of eighth tergite, fig. 4 ..... **flaveolus** (Coquillett)

   Seven to nine spines set closely to one another in middle of posterior margin of eighth tergite, fig. 5 ..... **titillans** (Walker)

The arrangement of the spines figured in **indubitans** (fig. 6) has been checked with a slide mount of the paratype from Rio Branco, Brazil, made for the writer by Alan Stone, U. S. National Museum. Specimens from Florida, Jamaica, and Puerto Rico show no intergradation between **indubitans** and **titillans**, although intergrades between **titillans** and **flaveolus** will probably be found by later workers. **Flaveolus** and **titillans**, however, are easily separated by other adult characters such as color and length of palpi.

Adult females of these three species may be separated by the following key adapted from Shannon (5):

Key to Adult Females

1 Abdomen covered entirely with bright golden scales; mesonotum generally yellowish brown, clothed with golden scales and isolated patches of dark scales; palpi of female exceeding one-half the length of the proboscis, fig. 1 ..... **flaveolus** (Coquillett)

   Abdomen mostly dark scaled; palpi of the female less than one-half the length of the proboscis 2

2. Palpi about one-fourth the length of the proboscis; small species, 3-4 mm. long, fig. 3 ..... **indubitans** Dyar and Shannon

   Palpi about one-third the length of the proboscis; small to moderate in size, 5-6 mm. long, fig. 2 ..... **titillans** (Walker)

Larvae of the three species may be separated from **Mansonia** (Coquillettidia) **perturbans** (Walker) by the toothed maxillary spine, the anal segment being ringed by a sclerotic plate and pierced by 4 precratal hairs, and the two long hairs arising from the median notch in the antennal shaft extending to or beyond the tip.

Larvae of the three Caribbean species may be separated by the following key:

Key to Larvae

1. Comb scales on eighth abdominal segment broad, with numerous coarse denticles, fig. 10 ..... **indubitans** Dyar and Shannon

   Comb scales on eighth abdominal segment narrow, with fine denticles 2

2. Precratal hairs piercing sclerotic ring surrounding anal segment single, **gamma** hair of pentad group on eighth segment single or double; hairs on air tube single, fig. 11 ..... **flaveolus** (Coquillett)

   Precratal hairs piercing sclerotic ring surrounding anal segment double or multiple; **gamma** hair of pentad group on eighth abdominal segment double or multiple; hair on air tube double or multiple, fig. 12 ..... **titillans (Walker)**

The pupae of Mansonia differ from those of all other New World mosquitoes in lacking the dendritic tuft on the first abdominal tergite, and in the tapered, pointed trumpet adapted to piercing the soft tissues of aquatic plants in order to obtain their air supply. The paddles have a peculiar notch on the inner margins and no apical paddle hair. The trumpet of **indubitans** specimens from Florida and Jamaica is longer than that of **flaveolus** specimens from Puerto Rico and Bonne Wepster's (2) figure of **titillans** from Dutch Guiana. A key to the pupae of **indubitans** and **flaveolus** is given below:

Key to Pupae

1. Pupal trumpet long and slender, at least five times as long as greatest diameter; abdominal hairs B and C on segments IV, V, VI and VII conspicuously developed; paddle slender, 3 times as long as greatest width, with strong marginal denticulation, fig. 14 ..... **indubitans** Dyar and Shannon

   Pupal trumpet short and stout, about three times as long as greatest diameter; abdominal hairs B and C on segments IV, V, VI, and VII weak and poorly developed; paddle broad, twice as long as greatest width, with slight marginal denticulation, fig. 13 ..... **flaveolus** (Coquillett)

At the present time **flaveolus** is known to occur in the Virgin Islands, Vieques, and Puerto Rico, Panama, and Brazil. All **titillans** records for the Virgin Islands, Vieques, and Puerto Rico probably should be referred to **flaveolus** on the basis of such characters as coloration, length of female palpi, and female genitalia. In Jamaica both **titillans** and **indubitans** are known to

occur. Shannon (5) has shown that many of the South American records of **titillans** refer either to species of **Psorophora** or to **M. indubitans.**

It is believed that some of the United States records of **Mansonia titillans** (Walker) reported in the literature actually are based on specimens of **Mansonia indubitans** Dyar and Shannon. It is hoped that a study of reared material will be made in the future and the specimens recorded in the literature will be re-examined to determine the distribution of these two easily confused species.

Acknowledgments

During the present study G. H. Bradley, Porter A. Stephens, and W. W. Wirth have made many helpful suggestions. The writer wishes to acknowledge also the assistance of A. E. Pritchard, C. E. Peres, D. G. Denning, in procuring specimens, and particularly of J. Maldonado Capriles and G. H. Thompson who helped with field work in Puerto Rico and Jamaica. Special acknowledgment is made herewith to Dr. Alan Stone of the U. S. National Museum for checking identification of specimens and for information regarding the types of **flaveolus** and **indubitans.**

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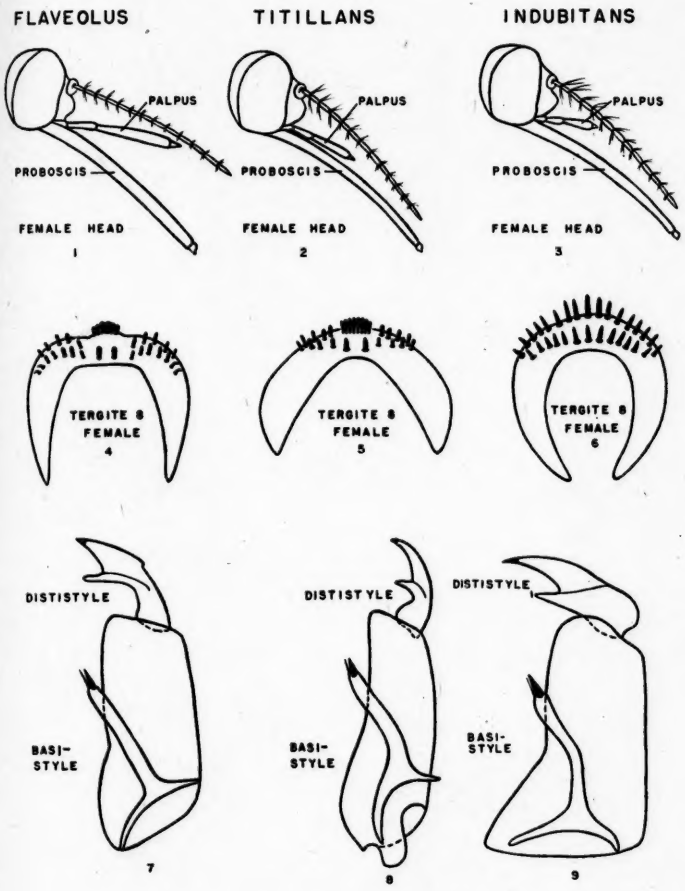
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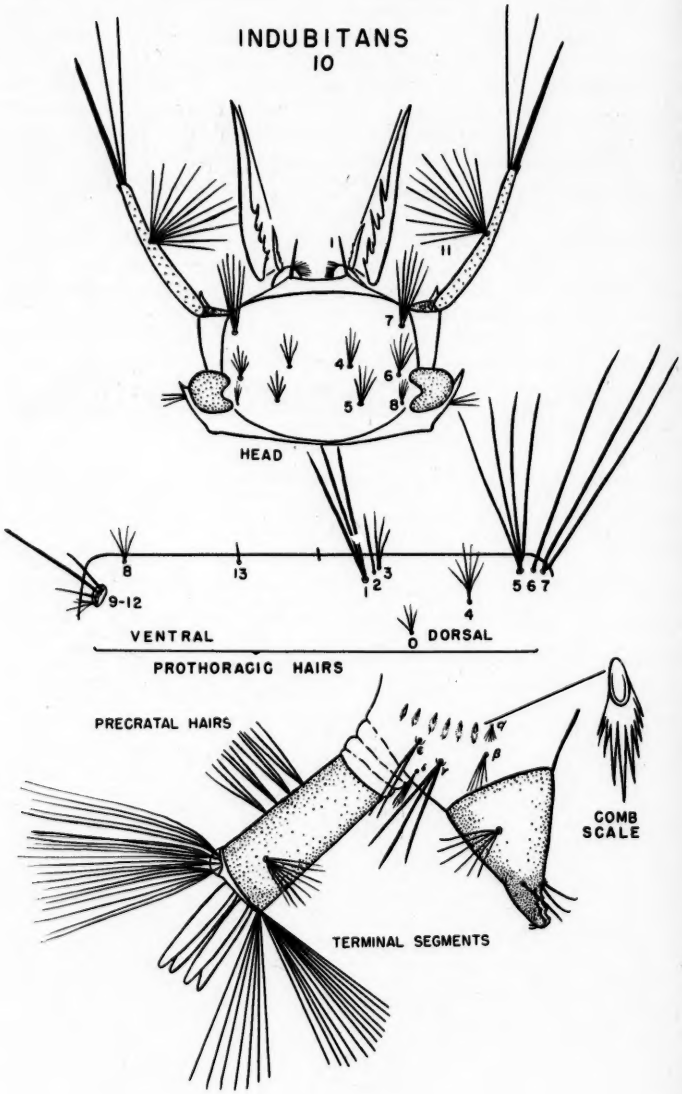
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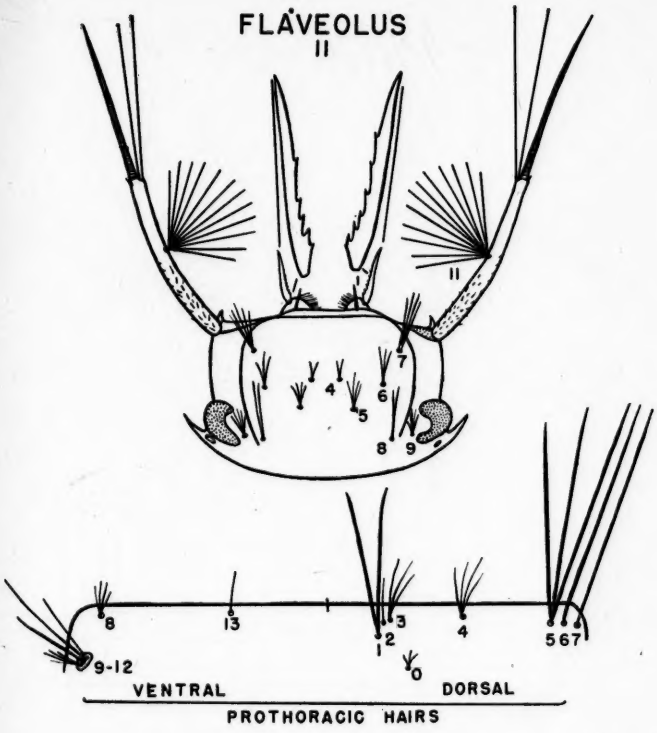
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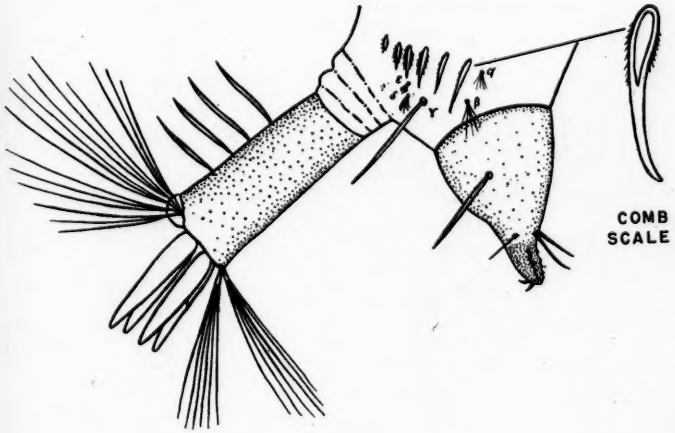
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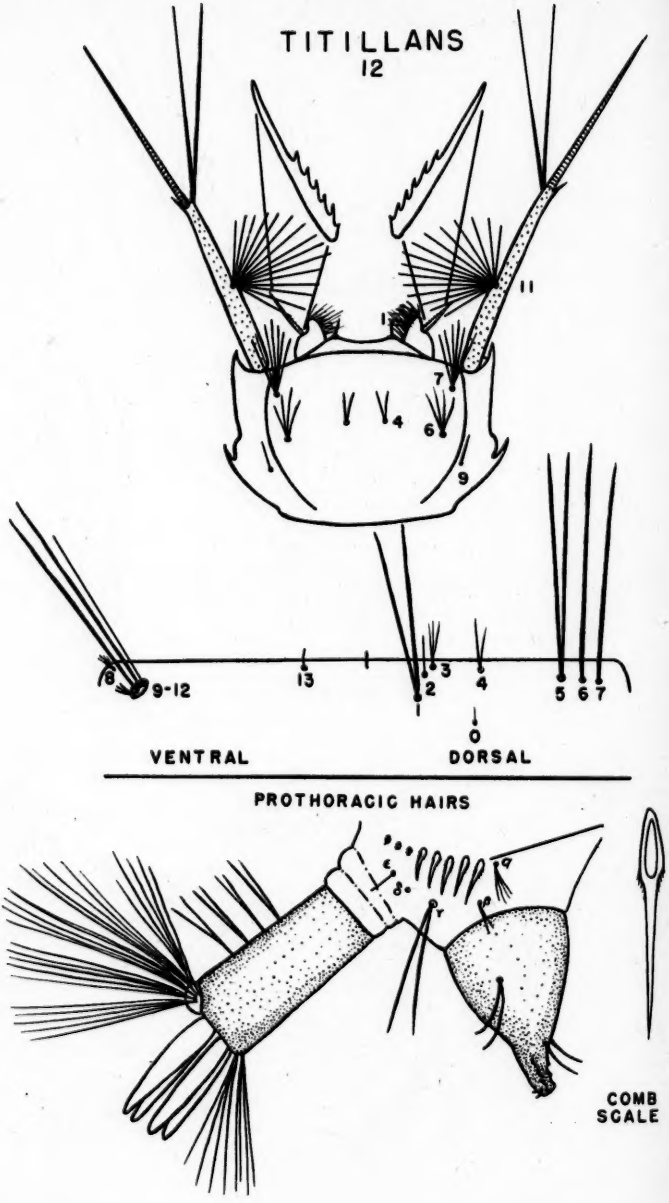
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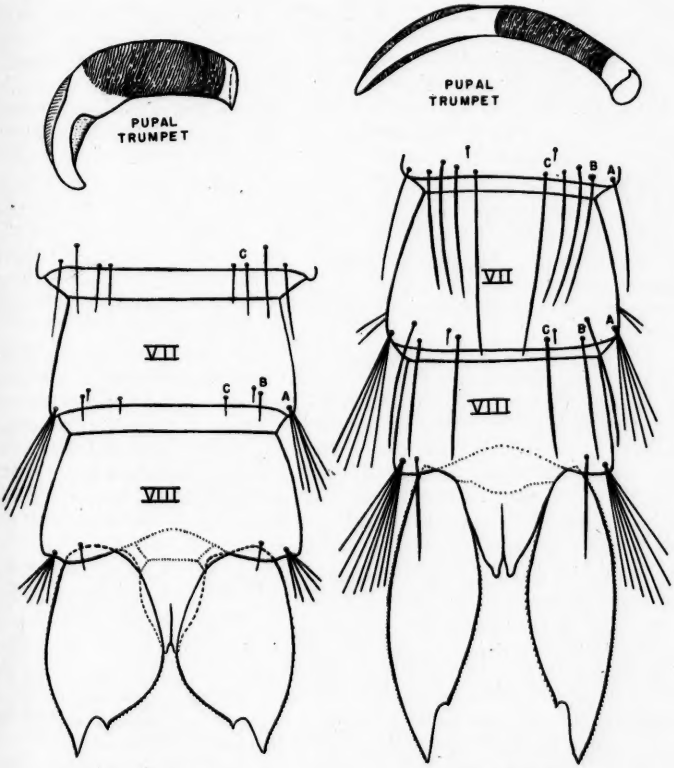

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INDUBITANS
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THE HESSIAN FLY RESISTANCE OF PAWNEE WHEAT[1]

REGINALD H. PAINTER and ELMER T. JONES[2]

The Pawnee variety of wheat was released to farmers in Nebraska in 1942 and to growers in Kansas and Oklahoma in 1943. In the fall of the latter year about 650 bushels of this wheat were planted in Kansas. This hard, red variety is recommended for planting in the eastern part of the hard-wheat belt. One reason for the release of this variety is that it exhibits considerable resistance to the hessian fly [**Phytophaga destructor** (Say)]. This paper is a report of the present status of this resistance and its possible importance in hessian fly control.

History of the variety.—Pawnee is a selection from the cross Kawvale x Tenmarq made in 1928 at the Kansas Agricultural Experiment Station primarily to combine the hessian fly resistance, leaf rust resistance, and desirable agronomic characters of Kawvale with the good bread-making and certain other characters of Tenmarq. Kawvale appeared to be the best available source of resistance to the hessian fly in varieties tested up to that time.

The first, second, and third generations of this cross were grown in Manhattan, Kans. Seed from a number of the third-generation plants was sent to Lincoln, Nebr., and the strain that was later named Pawnee was selected from the progeny of an F_3 plant in 1932. At the time of selection there was present in the Nebraska Agronomy Nursery a heavy natural infestation of the hessian fly (Kiesselbach et al., 1933; Suneson and Kiesselbach, 1934). The fly resistance of Pawnee at that time was partly responsible for bringing this strain to the attention of the agronomists. Since the choosing of the strain there has been little subsequent selection.

Review of literature.—Information concerning the characteristics of the parents of Pawnee, particularly with reference to hessian fly resistance, has been given in an earlier paper (Painter, et al., 1931). The history and characteristics of Pawnee have been given in several papers (Clark, 1943; Reitz and Laude, 1943; and Quisenberry and Kiesselbach, 1943). Data presented by Hollingsworth (1933) and subsequent investigations at the Kansas station indicate that resistance to the hessian fly tends to be dominant in Kawvale and its hybrids, but the number of factors involved is unknown.

Reitz and Laude (1943) reported that, in 42 station-years in Kansas, Pawnee showed an advantage in yield of 17 percent over Tenmarq, of 33 percent

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1 Contribution No. 535 of the Department of Entomology, Kansas Agricultural Experiment Station, Manhattan, Kans. Investigations conducted cooperatively by the Department of Entomology and the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture.

2 Associate entomologist, Kansas Agricultural Experiment Station, and associate entomologist, Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture, respectively. Thanks are due to members of the Department of Agronomy and Botany, Kansas Agricultural Experiment Station, and to H. C. Fryer, of the Department of Mathematics, for assistance in various phases of this investigation.

over Blackhull, and of 42 percent over Turkey. Keim (1943) reported a 30 percent excess over Turkey during 7 years of tests at Lincoln, Nebr. Most of the experiments reported in the papers just referred to were conducted in the absence of severe fly infestation, hence do not reflect the resistance of Pawnee to this insect.

Characteristics of Pawnee wheat.—Pawnee wheat has a unique combination of desirable characters. In addition to its innate yielding ability, Pawnee ordinarily has a higher test weight than its parents and many other hard, red winter wheats grown commercially. It is short, stiff-strawed and winter hardy, and matures early. As reported by Reitz and Laude (1943), Pawnee is practically immune to loose smut, resistant to some common forms of leaf and stem rust, and moderately resistant to stinking smut, or bunt. Pawnee is reported to have milling and baking qualities similar to those of Turkey wheat. Among the disadvantages of this variety may be mentioned its susceptibility to speckled leaf blotch (**Septoria**) and possibly greater susceptibility to green bug and chinch bug injury than that of Turkey wheat and some other common varieties. Thus, aside from its resistance to the hessian fly, Pawnee is a highly desirable wheat, with good inherent yielding capacity and possessing the best combination of wheat-pest resistance and other characteristics now available in a commercial winter wheat.

Data and methods of study.—The hessian fly resistance of Pawnee wheat has been studied along with that of other varieties and hybrids in special nurseries conducted by the Kansas Agricultural Experiment Station and the United States Bureau of Entomology and Plant Quarantine. Infestation was induced at Manhattan by bringing in infected stubble, as has been previously reported (Painter et al., 1931, 1940). Other tests have been conducted at Ramona and Bennington, Kans., and at Springfield, Mo., in areas of natural fly infestation. The accumulated records of hessian fly infestation in wheat varieties and hybrids from 1924 to 1943 at various localities in Kansas and Missouri are given in table 1. The infestation given in this table will indicate the position of Pawnee and its parents, Kawvale and Tenmarq, with reference to other commercially grown wheats, and also in contrast to hybrids involving Marquillo, which possess a higher degree of resistance in both the hard- and soft-wheat belts (Painter et al., 1940; Reitz et al., 1943; Jones, 1943).

During the last 3 years, in particular, records have been made of the infestation in cooperative wheat-variety tests conducted by the Kansas Department of Agronomy with farmers in many counties in Kansas. In these tests, in addition to information on fly infestation in a number of different parts of the State, it was possible to obtain data on the yield of Pawnee in comparison with Tenmarq under a considerable range of intensities of fly infestation.[3] Yields from these cooperative tests were obtained from ten

[3] The writers are indebted to A. L. Clapp and others of the Department of Agronomy, Kansas Agricultural Experiment Station, for the opportunity of collecting fly data at these tests and for information on subsequent yields.

1-rod lengths of a row of grain in drill rows scattered over a plot. Most of the plots were as wide as the drill and several hundred yards in length.

Table 1.—Accumulated records of hessian fly infestation in wheat varieties and hybrids, 1924-1943[1]

Variety and record No.	Station-year test	Average plants infested		Tenmarq in same test[2]	Remarks
		Variety named	Tenmarq in same tests		
	Number	Percent	Percent	Percent	
Kawvale-Marquillo × Kawvale-Tenmarq C.I. 12331	12	3	90	3	
Marquillo × Tenmarq 37FN1507	31	6	69	9	One of the best simple Marquillo hybrids.
Kawvale C.I. 8180	33	19	61	31	In hard-wheat area.
Kawvale C.I. 8180	18	77	82	94	In soft-wheat area.
Kawvale C.I. 8180	51	40	68	59	In both areas.
Pawnee C.I. 11669	21	39	68	57	In hard-wheat area.
Pawnee C.I. 11669	13	84	86	98	In soft-wheat area.
Pawnee C.I. 11669	34	55	75	73	In both areas.
Blackhull C.I. 6251	14	52	68	76	Somewhat tolerant.
Early Blackhull C.I. 8856	21	59	69	86	Somewhat tolerant.
Wichita C.I. 11952; Ks. 2739	15	74	82	90	Somewhat tolerant.
Tenmarq	51	68	68	100	
Chiefkan C.I. 11754	19	81	79	102	Somewhat tolerant.
Comanche C.I. 11673	17	83	80	104	
Turkey C.I. 1558	11	76	70	109	

[1] Records from both hard- and soft-wheat areas, except as noted.
[2] Percentage rating of variety named if Tenmarq were rated at 100.

In nurseries, particularly at Manhattan, Kawvale and Tenmarq have been under test since 1924, and the other varieties for different lengths of time.

The differences in fly infestation of the same wheat varieties in various parts of Kansas have been discussed previously (Painter et al., 1931), and similar factors have an important bearing on the resistance of Pawnee, as will be pointed out in this paper.

Resistance of Pawnee as measured by percentages of plants infested.—On 19 occasions Pawnee has been tested on a comparable basis with its parents, Kawvale and Tenmarq. The results of these tests, together with those of some earlier tests involving only Kawvale and Tenmarq, are given in

table 2. To facilitate comparison of the data, the infestation of Pawnee and Kawvale is also reported as a percentage of Tenmarq in the same test. The infestation in Tenmarq in these tests ranged from 25 to 100 percent, with an average of 65 percent. Under the same conditions Pawnee ranged in infestation from 0 to 94 percent with an average of 39 percent, and Kawvale from 0 to 64 percent, with an average of 28 percent. It is evident that, in general,

Table 2.—Hessian fly infestation records of Kawvale, Tenmarq, and Pawnee in the same tests in central Kansas

Year and Test	Kawvale in terms of infestation of Tenmarq in the same test	Actual plants infested			Pawnee in terms of infestation of Tenmarq in the same test
		Kawvale	Tenmarq	Pawnee	
	Percent	Percent	Percent	Percent	Percent
1924 fall, Manhattan (drilled)	12	7	60	—	—
1927 fall, Manhattan (drilled)	0	0	85	—	—
1929 fall, Manhattan (drilled)	6	4	62	—	—
1931 fall, Manhattan (drilled)	5	4	74	—	—
1932 fall, Manhattan (drilled)	14	8	56	—	—
1933 fall, Manhattan (drilled)	0	0	37	0	0
1934 fall, Manhattan (drilled)	62	32	52	42	81
1936 fall, Manhattan (spaced)	24	9	38	12	32
1936 fall, Junction City (spaced)	35	26	74	58	78
1938 spring, Junction City (drilled)	40	10	25	13	52
1939 fall, Manhattan (spaced)	0	0	29	0	0
1940 spring, Ramona (spaced)	115	39	34	17	50
1940 fall, Manhattan (drilled)	63	48	76	42	55
1940 fall, Ramona (drilled)	60	46	77	38	49
1940 fall, Manhattan (spaced)	38	21	55	33	60
1940 fall, Ramona (spaced)	56	32	57	32	56
1941 spring, Manhattan (spaced)	66	64	97	73	75
1941 spring, Ramona (spaced)	52	44	84	48	57
1941 fall, Manhattan (drilled)	29	22	77	30	39
1941 fall, Bennington (drilled)	38	21	55	38	69
1942 spring, Manhattan (drilled)	26	24	92	56	61
1942 spring, Bennington (drilled)	40	40	100	94	94
1942 fall, Manhattan (drilled)	26	20	76	48	63
1942 fall, Bennington (drilled)	30	29	98	60	61
13 station-years, average of fall records	35	24	62	33	49
6 station-years, average of spring records	56	37	72	50	65
19 station-years, average of all records	42	28	65	39	54

Pawnee had about one-half as high an infestation as Tenmarq and that Kawvale had a somewhat lower infestation than Pawnee. These data were analyzed by analysis of variance using the arc—sine transformation (Snedecor, 1940). The results of the analysis are given in table 3. They indicate that the difference between Tenmarq and the other two varieties is highly significant, as is the difference between spring and fall infestation, the former being generally higher in all cases. The analysis also indicated that the fly resistance, as measured by the percentage of plants infested, is different in Pawnee and Kawvale; hence it seems that not quite all the fly resistance of Kawvale has been inherited by Pawnee. It is possible that some of the genes for fly resistance possessed by Kawvale are absent or heterozygous in Pawnee. This is especially probable in view of the fact that this variety was selected in the third filial generation and has had little subsequent selection. It is possible also that Pawnee carries some strains that are fairly susceptible to the fly. In 1943 a considerable number of head-row selections of Pawnee were studied, and two of these were discarded because they appeared to be more susceptible to the fly than was the parent variety.

Table 3.—Analysis of 19 station-years' experiments on Pawnee, Kawvale, and Tenmarq, 1933-43 (Arc-sine transformation)

Source of variation	Degrees of freedom	Sum of squares	Mean square	P. less than
Between varieties	2	6,906.18	—	—
Tenmarq vs. others	1	6,454.56	6,454.56	0.001
Pawnee vs. Kawvale	1	451.61	451.61	0.020
Between experiments	18	—	—	—
Spring vs. fall	1	1,477.04	1,477.04	0.001
Experiments within seasons	17	11,024.15	648.48	0.001
Variety × experiment[1] (experimental error)	36	2,381.52	66.15	—
Total	56	21,788.88	—	—

[1] The variety × season interaction was small and is included in experimental error.

Fly resistance of Pawnee as measured by infestation of tillers.—The infestations of Pawnee and Tenmarq, as measured by both plant and tiller infestations in representative tests in various parts of Kansas, are given in table 4. The data here indicate that in general Pawnee has about one-fourth as high a tiller infestation as does Tenmarq. The lower infestations of both tillers and plants of Pawnee are primarily the results of the smaller numbers of larvae surviving from those that reach the normal feeding position (fig. 1). The tiller infestation in these two varieties reflects not only the resistance, as measured by plant infestation, but also the ability of Pawnee to grow more normally under fly infestation and to recover from the effects

of this infestation. This ability is spoken of as tolerance and is discussed later.

Geographical aspects of the fly resistance of Pawnee.—Pawnee and Kawvale have been grown and tested for fly resistance under various conditions and in a number of localities. In the soft-wheat area both varieties have shown little resistance, as measured by percentage of plants infested (table 1). In 18 tests in the soft-wheat area, mostly at Parsons, Kans., and Springfield, Mo., Kawvale had an average of 77 percent of the plants infested, while Tenmarq in the same test had 82 percent. In 13 tests in the same area Pawnee had 84 percent plant infestation as compared with 86 percent for Tenmarq. These results differ considerably from the results in the hard-wheat area of central Kansas, as recorded in tables 1 and 2 and discussed earlier in this paper.

Table 4.—Relation of tiller to plant infestation by the hessian fly in Pawnee and Tenmarq

Year and season	Pawnee		Tenmarq		Infestation in terms of Tenmarq infestation in the same test	
	Plants infested	Tillers infested	Plants infested	Tillers infested	Plants	Tillers
	Percent	Percent	Percent	Percent	Percent	Percent
1933 fall	0	0	37	8	0	0
1934 fall	42	20	59	31	71	65
1936 fall, Manhattan	12	2	38	8	32	25
1936 fall, Junction City	58	12	74	21	78	57
1942 spring, Dickinson County	20	7	60	33	33	21
1942 spring, McPherson County	28	8	68	29	41	28
1942 spring, Reno County	42	12	94	46	45	26
1942 spring, Ottawa County	12	2	72	20	17	10
1942 spring, Marshall County	8	1	84	28	10	4
1943 spring, McPherson County	48	8	100	57	48	14
1943 spring, Harvey County	94	28	100	47	94	60
Average					43	28

While Kawvale and Pawnee have been growing in cooperative and other tests in various parts of Kansas, records have been made of the infestation of these varieties and of Tenmarq in about 30 counties. These records are supported by casual observation of numerous fields of Kawvale and other varieties in the same areas. Most of the records have been obtained in the central counties, where it is expected that Pawnee will be grown most abundantly. The results of the studies, as measured by the infestation of Pawnee or Kawvale expressed in terms of infestation of Tenmarq, are given in the accompanying map (fig. 2). This gives a rough indication of the approximate area in which Pawnee shows its greatest resistance to the hessian fly.

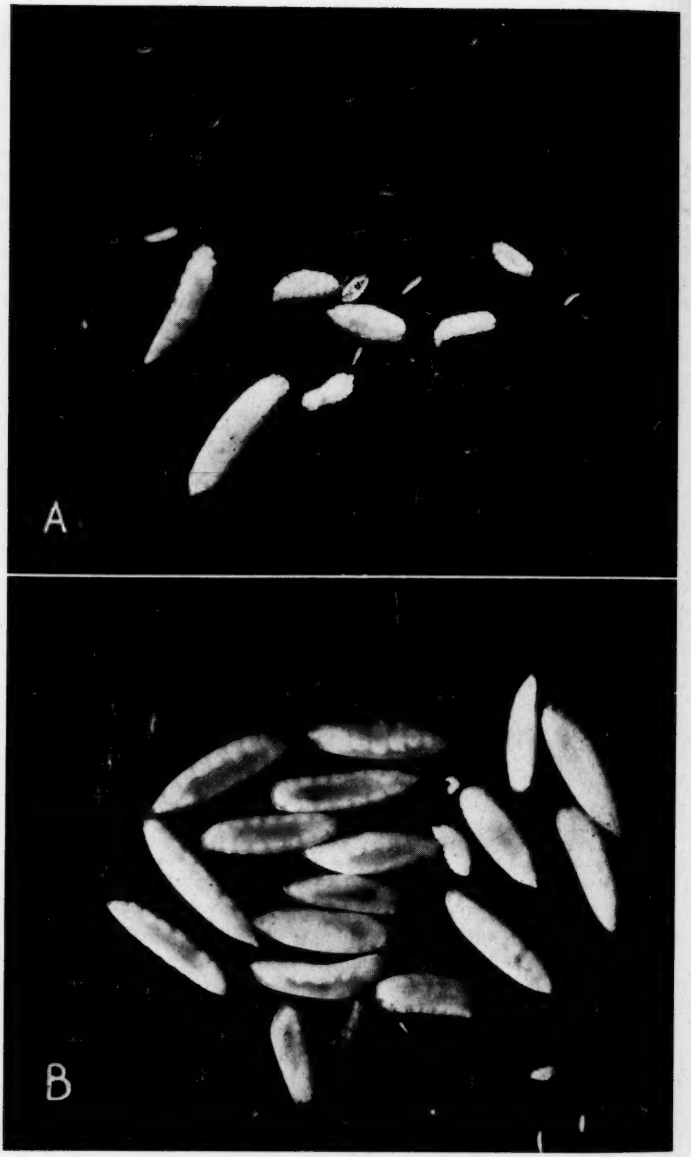

Fig. 1—Comparison of number and size of larvae and puparia of the hessian fly removed from 10 plants of A, Pawnee wheat, and B, Tenmarq wheat.

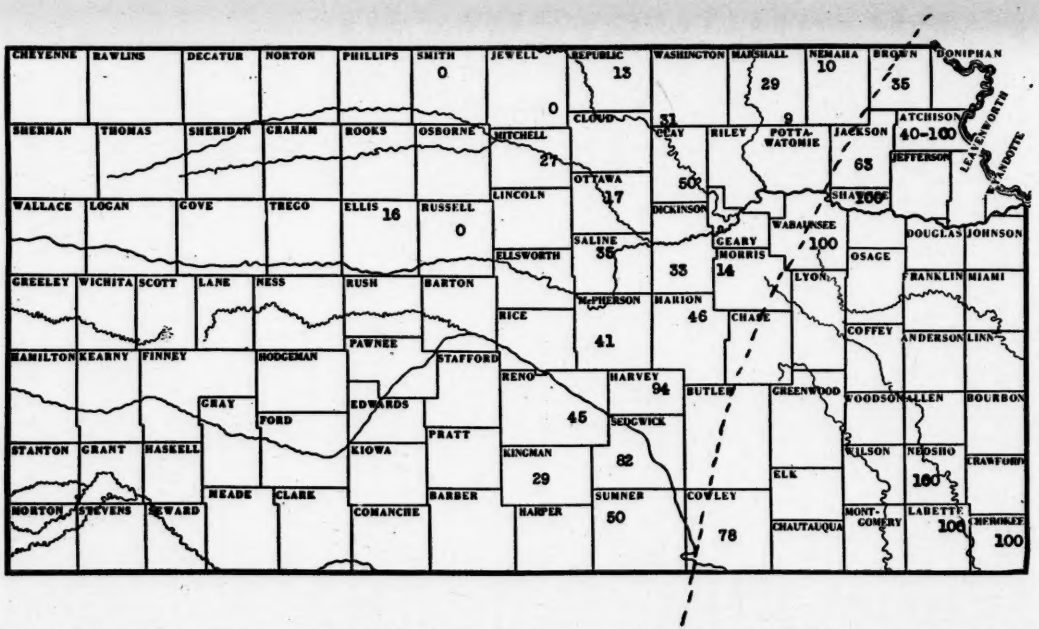

Fig. 2.—Infestations of Pawnee or Kawvale wheat in terms of percentage of infestation of Tenmarq in various counties in Kansas. The infestation tends to be lighter northwest of the broken line.

The data indicate that Kawvale and Pawnee are generally more resistant northwest of a line drawn from Brown County to Cowley County. There is, however, variability within this area. For instance, in Clay County the cooperative tests were grown in an area and in a field where Kawvale has been grown commonly for several years. The infestation in the test in this county has been somewhat higher in Kawvale and Pawnee than would be expected from infestations in neighboring counties. The high infestation in Harvey and Sedgwick Counties occurred in 1943 in single tests in which the intensity of infestation was much higher than in other experiments. Additional information on these tests are given later in this paper.

Much of the geographical variation in the resistance of Pawnee appears to be explainable by the existence of different strains of the fly in this region (Painter et al., 1931). There also is some evidence of a change in the composition of the fly population as measured by its ability to infest different varieties of wheat. Among the records given for Kawvale (table 2) the average for the first five tests at Manhattan showed an infestation of 5 percent in Kawvale and 67 percent in Tenmarq. A similar average for the last five tests at Manhattan showed an infestation in Kawvale of 30 percent and Tenmarq 79 percent. The increased infestation in Kawvale during this period (1924-42) is certainly not due to an increase in the level of infestation, but may be due to a change in the population.

In table 5 are given records of natural hessian fly infestation in plots of Kawvale and Tenmarq at Columbus, in extreme southeastern Kansas. These show that in the falls of 1928 and 1929 Kawvale had about one-half as high an infestation as Tenmarq. In 1941 there was a widespread outbreak of the hessian fly in southeastern Kansas. In this area in the intervening time Kawvale had become the dominant variety. No counts were available in 1941, but inspections of plots of Kawvale and Tenmarq and of numerous fields of Kawvale indicate that there were small if any differences between winter wheat varieties, including Kawvale, as measured by the percentage of plants infested.

Table 5.—Hessian fly infestation records in Kawvale and Tenmarq at Columbus, Kans.

Year and test	Infestation in Kawvale in terms of plants infested in Tenmarq in the same tests	Actual plants infested	
		Kawvale	Tenmarq
	Percent	Percent	Percent
Fall, 1928	47	18	38
Spring, 1929	16	13	80
Fall, 1929	59	51	87

Haseman (1933) reported that Illini Chief and other winter wheats that had shown considerable resistance to the fly in earlier experiments in Missouri did not show much resistance at the time of his tests.

The observations and records taken together seem to suggest that the part of the fly population able to infest Pawnee and Kawvale has been moving westward, or that the proportion of this strain has been increasing in the fly populations of the more western counties. This would indicate that an increase may be expected in the infestation of Pawnee, as measured by the percentage of plants infested, as the acreage of this variety in central Kansas increases.

Resistance of Pawnee wheat as measured by condition of hessian fly puparia and larvae.—A considerable number of hessian fly puparia from Kawvale, Pawnee, and Tenmarq have been weighed and measured, and typical average results are recorded in table 6. In some tests too few puparia were removed from the resistant varieties, but whenever an adequate sample has been obtained the puparia from Pawnee have averaged shorter than those from Tenmarq. In such tests this difference has been shown to be highly significant. The puparia removed from both Kawvale and Pawnee have weighed less on the average than those from Tenmarq. The average weight was calculated from the total weight of puparia from each kind of wheat; therefore statistical tests could not easily be applied. In measuring the length of puparia taken from different varieties, both the largest and smallest puparia have been found in Pawnee. Furthermore, the coefficient of variability nearly always has been higher for the puparia removed from Pawnee

Table 6.—Number of hessian fly puparia removed from Kawvale, Pawnee and Tenmarq wheats and their average length and weight

Variety	Manhattan, fall, 1940			Manhattan, fall, 1942	
	Puparia	Average length	Coefficient of variation	Puparia	Average weight
	Number	Mm.	Percent	Number	Mg.
Kawvale	118	3.37	16	22	0.96
Pawnee	86	3.44	13	56	1.24
Tenmarq	369	3.57	13	108	1.41
Difference between Pawnee and Tenmarq		.13[1]			.17

Variety	Manhattan, fall, 1942						Harvey County spring, 1943		
	First sample			Second sample					
	Puparia	Average length	Coefficient of variation	Puparia	Average length	Coefficient of variation	Puparia	Average length	Coefficient of variation
	Number	Mm.	Percent	Number	Mm.	Percent	Number	Mm.	Percent
Kawvale	—	—	—	—	—	—	—	—	—
Pawnee	538	3.86	16	471	3.30	15	195	3.37	19
Tenmarq	542	3.57	12	333	3.44	12	222	3.65	12
Difference		.29[1]			.14[1]			.28[1]	

[1] Highly significant.

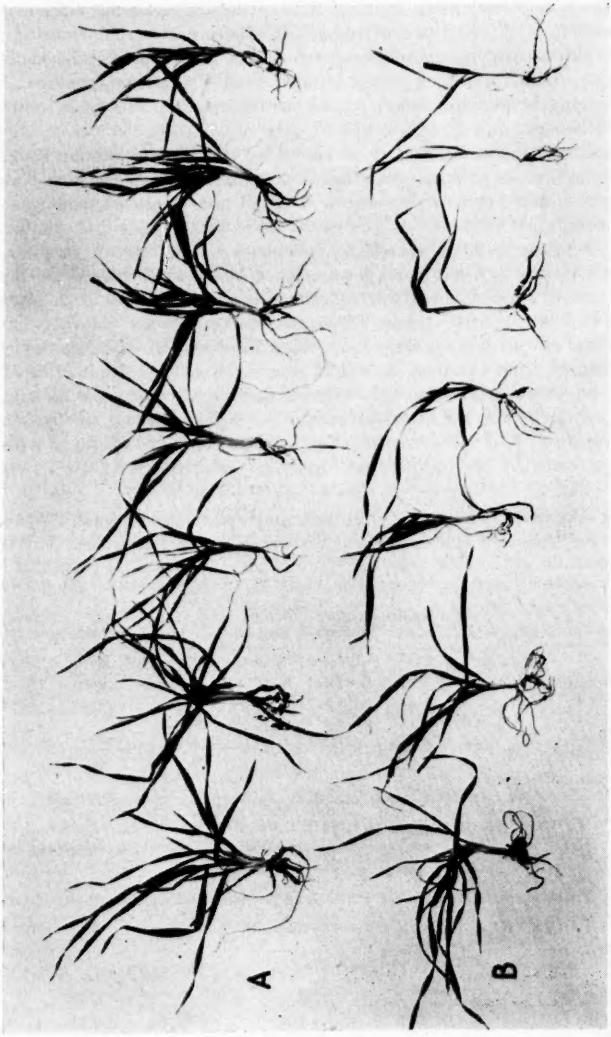

Fig. 3—Representative wheat plants of the same age removed from fields of A, Pawnee and B, Tenmarq. The plant on the left in each row is uninfested; the others are infested and show various degrees of injury by the hessian fly.

than for those removed from Tenmarq. This greater variability in puparia from Pawnee is perhaps further evidence of the presence of different strains of the fly.

Repeated observations made while taking records of infestation on Pawnee, Kawvale, and Tenmarq appear to indicate that development of the hessian fly is slower on Pawnee and Kawvale than on Tenmarq. In samples taken at the time when puparia are developing, most of the flies removed from Tenmarq will have already reached the puparium stage, while most of the forms taken from Pawnee and Kawvale still will be small larvæ (fig. 1). Detailed life-history studies on these varieties, however, have not yet been made.

In the spring of 1943, more than one thousand puparia from Tenmarq and Pawnee were placed in separate bottles, and adult flies were permitted to emerge from them under conditions as nearly comparable as possible. Flies emerged from 69 percent of the puparia removed from Tenmarq and from only 53 percent of those removed from Pawnee. This difference of 16 percent, while statistically significant, may not be due entirely to the varieties, because it was necessary to obtain these puparia from different but neighboring fields. Casual observation of similar lots of puparia tend to confirm the view that there is possibly a somewhat higher mortality in puparia removed from Pawnee than in those removed from Tenmarq. Furthermore, occasional dead larvæ have been observed on Pawnee and Kawvale but not on Tenmarq. Under some conditions in the greenhouse, and less frequently in the field, the smaller puparia on these resistant varieties have been observed to be pushed out from behind the sheath by the growth of the wheat tiller.

The resistance of Pawnee as measured by the damage to and survival of infested plants.—Both Pawnee and its resistant parent, Kawvale, show a high degree of tolerance or ability to recover and produce wheat crops in spite of infestation. This tolerance takes many forms, some of which cannot easily be measured quantitatively. It is shown best by pictures (Figs. 3, 4, 5), which indicate the difference in the amount of growth of individual plants following infestation. In Tenmarq and other susceptible varieties there are many more infested plants that appear to be similar to those in Figure 3, B, right, than are ever found in Pawnee or Kawvale. It will be noted that the infested plants of Pawnee differ from those of Tenmarq, not only in their greater leaf growth, but also in their ability to tiller after infestation. Both these factors are important when wheat is used as pasture, as is done in many parts of central and western Kansas. A considerable number of these smaller plants die after infestation, either before or during the winter. The differences in tolerance and degree of infestation between Pawnee and Turkey are apparent in figure 4. These differences during the fall are reflected in the straw and grain produced the next spring (Fig. 5). The spring generation of the fly causes additional damage, and fewer heads

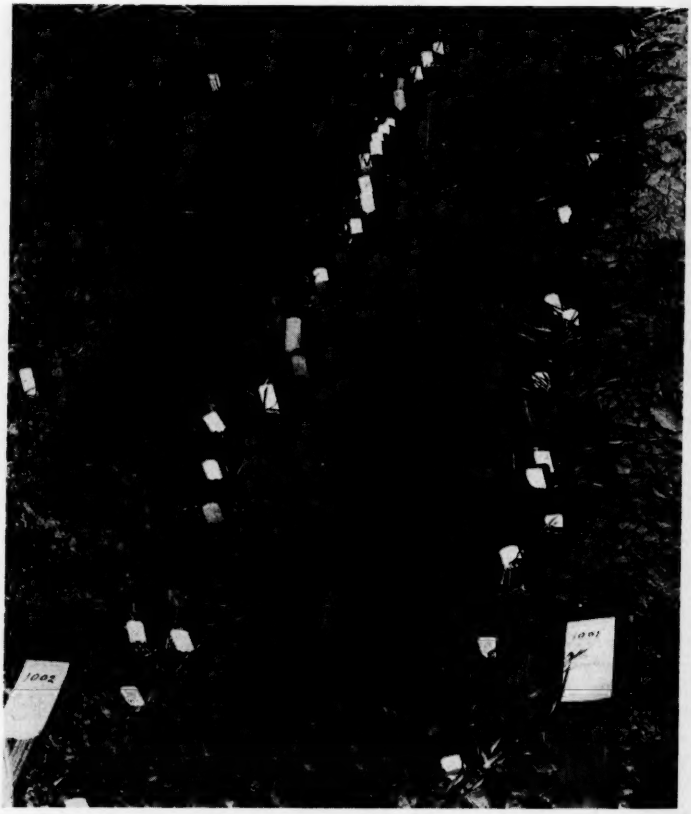

Fig. 4—Adjacent rows of Pawnee (1001) and Turkey (1002) in the Manhattan, Kans., hessian fly nursery in November 1942, indicate the difference in growth following infestation. A small stake marks each infested plant. In Turkey, 92 percent of the plants were infested, but in Pawnee only 33 percent.

are produced on susceptible varieties than on Pawnee. The appearance of the plants shown in Figure 5 reflects this spring difference as well.

In addition to the difference shown in these photographs between susceptible and resistant varieties, there is considerable difference in the survival of infested plants of Pawnee, as contrasted with the survival in susceptible varieties, such as Tenmarq and Turkey. Examples of this type of

Fig. 5—Total plants collected from the rows of Pawnee (1) and Turkey (2) in June 1943, from the same rows shown in figure 4 in an earlier stage of growth.

tolerance were found in detailed observations of 600 infested plants in the Manhattan nursery, where 16 percent of these plants in the variety Turkey, 6 percent in Tenmarq, and none in Pawnee were dead on November 25, 1942, whereas 71, 33, and 6 percent, respectively, were dead on March 15, 1943. The data on these infested plants were taken from adjoining rows, the same plants being observed in November and again in March. The data show that an appreciable number of the infested plants of Turkey and Ten-

marq die before they have encountered much winter weather, and a larger proportion of such plants die during the winter. In Pawnee, on the contrary, few dead infested plants are ever found, even in the spring. Normal, uninfested plants of Turkey are much more winter hardy than are plants of Tenmarq and somewhat more winter hardy than plants of Pawnee. The degree to which tolerance, as measured by the survival of infested plants, occurs is usually roughly proportional to the intensity of infestation, but is also greatly influenced by the age of the plants at the time of infestation and by the moisture conditions and fertility of the soil.

This difference in tolerance between Kawvale or Pawnee, and Tenmarq or Turkey, does not appear to be associated to a great extent with the area in which the test is grown. It was observed in the case of Kawvale in Missouri (Etheridge and Helm 1938) and in Leavenworth County, Kans., in 1932 and on several occasions at Springfield, Mo. For instance, in the extremely heavy infestation at the latter locations in 1935-36 Kawvale had the highest survival after infestation of any commercial winter wheat—a survival, however, of only 21 percent in this case.

Combined resistance and tolerance of Pawnee as reflected in yield under hessian fly infestation.—As indicated earlier, Pawnee has averaged about 17 percent higher in yield than Tenmarq under a wide range of Kansas conditions when the hessian fly was absent or infestations were only light. During the last 3 years records have been made whenever possible of the infestation of Pawnee and Tenmarq in cooperative tests conducted by the Kansas Department of Agronomy. The results of these infestation studies and the yields from the same plots are given in table 7. It may be noted that, in general, as the level of infestation increased the difference in yield between Pawnee and Tenmarq also increased. For instance, in the five counties where infestation records were taken in the spring of 1942, 76 percent of the Tenmarq plants were infested and Pawnee had 22 percent of plants infested, which was 29 percent of the infestation of Tenmarq. The average increase in yield of Pawnee over Tenmarq was 8.5 bushels, or 31 percent. In the spring of 1943, three counties in south-central Kansas, McPherson, Sedgwick, and Harvey, had 100 percent of the Tenmarq plants infested, and the infestation in Pawnee was 75 percent of that in Tenmarq. The average increase in yield of Pawnee over Tenmarq was 13.3 bushels, or 83 percent.

The relationship between yield and hessian fly infestation, as measured by the percentage of plants infested, does not appear to be a simple one. This is to be expected, since yield normally depends on many different factors. There are also indications in table 7 that phases of the resistance of Pawnee, other than percentage of plants infested, may be of equal or greater importance as reflected in yield. For instance, in Sedgwick County in 1943 the difference in infestation between Pawnee and Tenmarq was only 18 percent, yet the difference in yield was 66 percent, and in Harvey County the same year the difference between Pawnee and Tenmarq in plants infested was 6 percent, yet the difference in yield was 70 percent. In the latter case

Table 7.—Relation of hessian fly infestation to yield in various parts of Kansas. Vacant places in table indicate lack of data.

Table 7.—Relation of hessian fly infestation to yield in various parts of Kansas. Vacant places in table indicate lack of data.

County and Harvest Year	Pawnee: Fall, infested plants	Pawnee: Spring, infested— Plants	Pawnee: Spring, infested— Tillers	Pawnee: Yield per acre	Tenmarq: Fall, infested plants	Tenmarq: Spring, infested Plants	Tenmarq: Spring, infested Tillers	Tenmarq: Yield per acre	Yield Relation to Tenmarq: Difference	Yield Relation to Tenmarq: Percent	Remarks
	Percent	Percent	Percent	Bushels	Percent	Percent	Percent	Bushels	Bushels	Percent	
Central and N.E. Kansas tests:											
Nemeha, 1941	1		13	34.2	12		76	21.9	12.3	56	
Clay, 1941			38	34.9			89	36.6	—1.7	—5	
Marshall, 1941	10		16	16.4	22		42	Not harvested			
Marshall, 1942		8	1	40.0		84	28	25.7	14.3	56	
Ottawa, 1942		12	2	38.8		72	20	35.5	3.3	9	
Dickinson, 1942		20	7	26.8		60	33	16.4	10.4	63	
McPherson, 1942	5	28	8	39.2	14	68	29	31.9	7.3	23	
Reno, 1942		42	12	32.7		94	46	25.7	7.0	27	[1]
Sumner, 1942	8			31.4	16			28.6	2.8	10	
Russell, 1943		0		37.5		24		34.7	2.8	8	
Smith, 1943		0		21.9		40		22.1	—0.2	—1	Injured by drought.[1, 2]
Jewell, 1943		0		27.7		68		28.8	—1.1	—4	Little evident injury in field.
Marshall, 1943		8		41.3		86		38.2	3.1	8	do.
Republic, 1943		8		21.9		64		14.2	7.7	54	[1]
Morris, 1943		4				29					Fall infestation light, plot destroyed by hail.
Mitchell, 1943		16		47.5		60		33.6	13.9	41	Fall infestation light.
Kingman, 1943		8		22.7		28		14.7	8.0	54	[1]
Washington, 1943		20		27.7		64		21.8	5.9	27	[2]
Saline, 1943		17		30.9		48		28.2	2.7	10	Fall infestation light.
Brown, 1943		32		25.6		92		14.6	11.0	75	[3]
McPherson, 1943		48	8	17.9		100	57	8.4	9.5	113	[3]
Sedgwick, 1943		82		36.4		100		21.9	14.5	66	[1]
Clay, 1943		72		51.8		80		29.5	22.3	76	In field of Kawvale.
Harvey, 1943		94	28	38.6		100	47	22.7	15.9	70	[2, 3]
Reno, 1943	12			27.3	50			11.7	15.6	133	No data available on heavy spring infestation.[1, 3]
Eastern Kansas tests:											
Atchison, 1941	34		31	45.4	56		26	31.3	14.1	45	
Wabaunsee, 1942		77	47	25.0		78	32	19.0	6.0	32	[3]
Shawnee, 1943		72		29.4		72		24.8	4.6	19	

[1] Experimental fields.
[2] Planted after safe seeding date.
[3] Injury to Tenmarq evident in field.

the damage by the fly was done entirely by the spring generation, since the test was planted after the safe seeding date and received little or no fall infestation. Hence the ability of Pawnee both to produce grain and to survive the winter under heavy fly infestation is an important characteristic of the variety.

The tests in eastern Kansas gave further indication of the inadequacy of the percentage of plants infested as a measure of the resistance of Pawnee wheat. Although the percentages of infested plants in Pawnee and Tenmarq were about equal, in these tests the difference in yield was great and larger than the average difference in yield when the hessian fly was present in only small numbers, as reported by Reitz and Laude (1943) and as discussed under "Review of Literature."

In years of severe hessian fly outbreaks many cases of crop failure have been due to the death of the fall-infested wheat plants. The consequent abandonment of fields in the fall or early in the spring has contributed greatly to the losses caused by this insect in central Kansas, and even more to the losses suffered by individual farmers. Taken together with observations in severe infestations of the hessian fly in nurseries, the yield data presented indicate that when Pawnee is used in the area in which it is adapted there is little possibility of a complete crop failure due to fly damage.

Measuring resistance to the hessian fly in Pawnee wheat—As has been repeatedly indicated in this paper, the percentage of plants infested does not completely, and sometimes does not correctly, measure the difference between Pawnee and such susceptible varieties as Tenmarq and Turkey. Neither, for that matter, does any other single criterion. Although yield is affected by many factors besides hessian fly resistance, and some of these factors, such as resistance to disease, may be of dominant importance in some years, yield is perhaps the best single measure of the combined resistance and tolerance of Pawnee under heavy fly infestation. For a correct evaluation, however, the several methods of measuring resistance in addition to percentage of plants and tillers infested must be considered. It is especially necessary to consider the survival of infested plants and the ability of Pawnee to replace infested tillers or to produce adequate vegetative growth and heads, regardless of infestation. It is much more difficult, however, to get a quantitative measure of these last-named characteristics.

Possible changes in status of resistance in Pawnee wheat to hessian fly.—It seems probable, from the superior characteristics of the variety, that the use of Pawnee is likely to spread quickly, and that this wheat will occupy considerable acreage in the area to which it is adapted. The evidence presented of a geographical limitation of the part of Pawnee resistance that is measured by percentage of plants infested, and the evidence of a possible westward increase in the eastern type of fly, bring up the question of the permanence of Pawnee's resistance under Kansas farm conditions. This question already has been discussed by Painter (1941, p. 362) in general

terms. The case of Pawnee, which was studied at that time, had a bearing on this discussion. Little can be added to the seven factors mentioned at that time. The present writers have no evidence to indicate how much change may be expected in the fly resistance of Pawnee; neither do they have any information on how rapidly or how far west the eastern type of fly is likely to spread. This may depend in part on the ability of the eastern strain to survive or to develop under the drier condition of central and western Kansas.

There seems to be good evidence, however, that the westward spread of the eastern type of fly may result in some increase in infestation of Pawnee. On the other hand it has been shown earlier in this paper that the tolerance factors possessed by Pawnee are effective against the eastern as well as the western type of fly, and apparently will not be affected, except as related to an increase in the number of plants or tillers infested. Even if there should be a considerable decrease in the resistance of Pawnee, this variety would continue to be a superior wheat for other reasons. Furthermore, certain hybrids from other parent varieties of wheat now under test are much more fly resistant than Pawnee. New varieties from these hybrids may eventually replace Pawnee if it becomes susceptible to infestation.

The place of Pawnee in hessian fly control.—It seems evident from what has been said that other control measures for the hessian fly in addition to the use of Pawnee should be employed where possible, in order to increase the effect of Pawnee resistance on yield and to delay the spread and multiplication of hessian fly strains that are able to breed on Pawnee. In table 7 it is shown that one of the greatest difference in yield between Pawnee and Tenmarq occurred in 1943 in Harvey County in a test which, because other means of control had been employed, had little, if any, fall fly infestation. Regardless of other control measures employed and of the possible increase in susceptibility of Pawnee, farmers can obtain some degree of automatic fly control through the use of that variety. Because of the effectiveness of the tolerance factors, it appears that complete crop failures due to fly infestation are not likely to occur where Pawnee is planted. Such complete crop failures from fly infestation have occurred repeatedly in central Kansas on individual farms where the present nonresistant hard, red winter wheats have been planted.

One of the important advantages to be gained from the use of Pawnee is a possible increase in available pasturage as a result of its resistance to both rust and the fly in the fall. In many parts of Kansas the use of wheat as fall, winter, and early-spring pasture approaches in importance its use as a grain crop. This value of Pawnee cannot be stressed too greatly. In years and locations in which there is little danger of a hessian fly outbreak, it may be possible to plant Pawnee somewhat earlier than susceptible varieties could be planted and thus to obtain additional value from its use as a pasture crop.

In regard to fly infestation and injury, differences similar to those between Pawnee and Tenmarq also occur between Pawnee and other hard, red winter wheats, such as Turkey and Comanche, for which less detailed data are available.

Summary.—The wheat variety Pawnee is a selection of Kawvale × Tenmarq and is a result of a cooperative breeding project directed in part toward the production of a hessian fly-resistant wheat for central Kansas. This new variety, however, has other outstanding characteristics of commercial value.

The value of Pawnee is a result of both tolerance and resistance to the fly in central Kansas and is shown by (1) a 50-percent lower infestation than the suscepitible variety Tenmarq, as measured by percentage of plants infested; (2) approximately a 75-percent lower tiller infestation, as compared with the susceptible variety Tenmarq; (3) a decrease in the size of puparia and a decreased rate of development, and perhaps other biological differences; (4) comparatively low fly injury to infested plants, especially in the fall, and to individually infested tillers in both fall and spring; and (5) an excess in yield in comparison with Tenmarq, up to more than twice as much as the latter variety under heavy fly infestation. In evaluating the hessian fly resistance of Pawnee, it is necessary to consider all these factors.

Evidence has been presented that resistance, as measured by percentage of plants infested, may be decreasing, because of the westward migration and survival of strains of the fly that are able to infest such varieties as Pawnee and Kawvale. The tolerance factors do not appear to be greatly affected by any differences in the resistance of Pawnee to the strains of fly prevalent in different areas. If the sowing of Pawnee reduces fly damage in central Kansas for only a few years, it will prove of great economic value and, even though this resistance may be lost, Pawnee would still have the other desirable characteristics to recommend it.

Pawnee should be used primarily as an additional means of hessian fly control, and if so used will give increased yield under fly conditions. The use of other control measures possibly will delay the spread or development of the type of fly able to survive on Pawnee.

Owing to its tolerance and resistance, the use of Pawnee wheat reduces the possibility of total crop failure from fly infestation.

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FOUR NEW SPECIES IN THE GENUS BAKERELLA

(Homoptera-Fulgoridae-Delphacinae)

R. H. BEAMER*

The genus Bakerella was described by David L. Crawford (Proc. U.S.N.M., Vol. 46, p. 601, 1914) with the Mexican species **Bakerella maculata** as genotype. The specimens of this genus from America north of Mexico have heretofore not been separated from **B. maculata.** The present paper describes four new species. The specimens of these were compared with the type of **B. maculata** in the United States National Museum by Doctor John Caldwell. It is his opinion that they are undescribed.

Key to the Species

1. General form very robust (Mexico) ..... **maculata** Craw.
   General form more slender 2

2. Frons almost as wide as long ..... **rotundifrons** n. sp.
   Frons much longer than wide 3

3. Anal ring of male without processes ..... **bidens** n. sp.
   Anal ring with processes 4

4. Long wing forms with broad diagonal, fumose band from costa to mesal margin on outer third of clavus; aedeagus swollen dorsally on basal half ..... **fusca** n. sp.
   Long wing forms with barely a spot left of diagonal band; aedeagus swollen ventrally on basal half ..... **cinerea** n. sp.

* Contribution from Department of Entomology, University of Kansas, Lawrence, Kan.

1. **Bakerella fusca** n. sp.

Macropterous form

Resembling **B. maculata** Crawford but less robust, median fovea of crown broader and slightly shorter. Length male 2.75-3 mm.

Structure: Front about twice as long as wide, oval in shape, about as wide at union with clypeus as next crown; crown slightly longer than width between eyes, anterior fovea about twice as long as width at base, posterior fovea about twice as wide at base as length at middle; veins of elytra sparsely set with small, rounded projections.

Color: Front brown with three or four pairs of small mesal spots, usually one pair near clypeus, one pair just above middle and two pairs near union with vertex; three marginal spots, one near middle, one just above it and one near union with crown, light. Crown brown with lateral carina, base and sometimes other carina, light. Pronotum brown with mesal carina, posterior margin and sometimes a spot back of lateral carina, light. Elytra hyaline with diagonal band from spot on mesal border near apex of claval veins to costal margin more or less paralleling posterior margin of pronotum, band on cross veins extending to apex on Cu and M_{3+4} and small round bumps on veins, brown. Venter variegated, more brown than light.

Genitalia: Styles in lateral view widest at base, contracted on basal fourth, narrowed to apex and gently curved ventrally near middle; aedeagus in lateral view widest just beyond base, then narrowing on dorsal margin with about five retrorse dorsal teeth just before bluntly pointed apex. Anal segment with a pair of contiguous processes enlarged near their middle and about as long as diameter of segment.

Holotype male and 1 male paratype, Apache Co., Arizona, July 16, 1927, P. A. Readio. Types in the Snow Entomological Collections.

2. **Bakerella cinerea** n. sp.

Brachypterous form

Resembling **B. fusca** but wings cinereous instead of hyaline, diagonal dark stripe almost lacking, aedeagus swollen basally on ventral side instead of dorsally and apex with much larger teeth, not evenly spaced. Length: male 1.5 mm.; female 1.75-2 mm.

Structure: Front oval, widest just above middle, slightly wider at union with crown than with clypeus; crown rectangular, about one fourth longer than width between eyes, anterior fovea about twice as wide as long, posterior fovea about twice as long as wide, divided longitudinally with a ridge; elytra reaching to second abdominal segment, apices rounded, longest near middle of inner half, female more nearly truncate than in male, veins raised, rather evenly and sparsely set with round bumps.

Color: Front brown, usually with four pairs of small mesal light spots, one pair near distal end, one pair midway between middle and clypeus, one just above middle and one almost at union with crown; four marginal light spots, one at apex, one about the middle, another opposite middle spots and the

other near union with crown, all usually crossing lateral ridge and face; crown and pronotum dark with ridges usually lighter; elytra cinereous with rounded bumps on veins, two spots on mesal margin, one near middle and other at apex of clavus and a rather broad band at apex of elytra, except two mesal white spots, brown; venter brown to black, more or less spotted with light, pygofer and ovipositor of female black, bordered by light-margined notch of last ventral segment.

Genitalia: Styles about as in **B. fusca**; aedeagus in lateral view enlarged on ventral margin for basal two thirds, then constricted on outer fourth to less than one third greatest width, tip somewhat enlarged again on ventral side with five large, different-sized teeth on apical third of dorsal margin, anal segment about as in **B. fusca.**

Holotype male, allotype female, 16 male and 28 female paratypes, Lawrence, Kansas, Sept. 20, 1944, R. H. Beamer; other paratypes: 1 male and 2 females, August 23; 2 males and 1 female, September 4, same place, year and collector; 14 males and 7 females, Douglas Co., Kansas, Oct. 19, 1944, R. H. Beamer; 39 males and 17 females, Oct. 17; 2 males and 1 female, Oct. 18; 2 males Nov. 18; 1 male, Oct. 26, same place, year and collector.

Macropterous form

Like the short-winged form except wings much longer than abdomen. Length male 3.25 mm. Elytra cinereous to semihyaline, veins raised with black bumps except on claval suture, black spot on mesal margin near basal third of clavus, another almost at apex, a third near center of corium on a diagonal with this last spot and costal margin, all parallel with posterior margin of pronotum; broad, dark band on cross veins running to apex of elytra along veins M_{3+4}, Cu_1 and Cu_2.

Holomorphotype male, Lawrence, Kansas, August 23, 1944, R. H. Beamer, and 2 male paramorphotypes, same place and collector, Sept. 20, 1944; 1 male paramorphotype, Douglas Co., Kansas, August 17, 1944, R. H. Beamer.

Types in the Snow Entomological Collections. The specimens of this species were swept from the sedge, **Eleocharis palustris** (L.).

3. **Bakerella rotundifrons** n. sp.

Brachypterous form

Resembling **B. cinerea** but front almost as wide as long, anal hooks of male forming a rounded curve and aedeagus with many spines on apical portion. Length female 1.75-2.25 mm.; male 1.25-1.75 mm.

Structure: Front almost as wide just above middle as median length, at union with clypeus slightly narrower than half greatest width; crown rectangular, about a third longer than wide, anterior fovea about three times as long as basal width, carinae distinct; elytra about as long as head and pronotum, oval in outline, veins definite with rather evenly arranged raised round black bumps, dorsal segments of abdomen with rather sharp median keel, the third segment with a pair of raised bumps on each side and the fourth with three smaller raised places on each side.

Color: The general color varies from buff to dark brown with the lighter individuals predominating. Front buff with at least a darker spot at apex and often apical third darker, usually four pairs of median and three marginal spots lighter; carina of crown and pronotum usually lighter; elytra semihyaline with raised round bumps on veins and two larger spots at apex dark brown; venter much darker than dorsum.

Genitalia: Male styles in lateral view almost straight, widest at base; sharply narrowed, then tapered to rounded apex; aedeagus in lateral view, with sides almost parallel and widest on basal two thirds, gently curving ventrally and narrowing on outer third, narrowed portion except apex covered with fine teeth; anal hooks broad at base, evenly curved ventrally from base to apices.

Holotype male, allotype female, 57 males and 42 females, Sun City, Kansas, Sept. 14, 1944, R. H. Beamer; other paratypes: 11 males and 16 females, Meade Co., Kansas, Sept. 9, 1944, R. H. Beamer; 2 males and 1 female, Douglas Co., Kansas, Oct. 17, 1944, R. H. Beamer; 1 male and 2 females, same place and collector, Oct. 20, 1944; 5 males and 8 females, Lawrence, Kansas, Sept. 20, 1944, R. H. Beamer.

Macropterous form

Resembling brachypterous forms but larger, generally darker and with wings about a third longer than body. Length of body 2 mm., to tip of wings 2.75 mm. Elytra hyaline except diagonal fuscous band from apices of claval veins to costa, paralleling pronotum and broader band on cross veins and extending to apex on M_2 and M_{3+4}; veins raised with rather evenly spaced, round, black bumps.

Holomorphotype female and 6 female paramorphotypes, Sun City, Kansas, Sept. 14, 1944, R. H. Beamer.

Types in the Snow Entomological Collections.

4. **Bakerella bidens** n. sp.

Brachypterous form

Resembling **B. cinerea** but front narrower, round bumps on veins of wings very slightly darkened if at all, male aedeagus bent ventrally at a right

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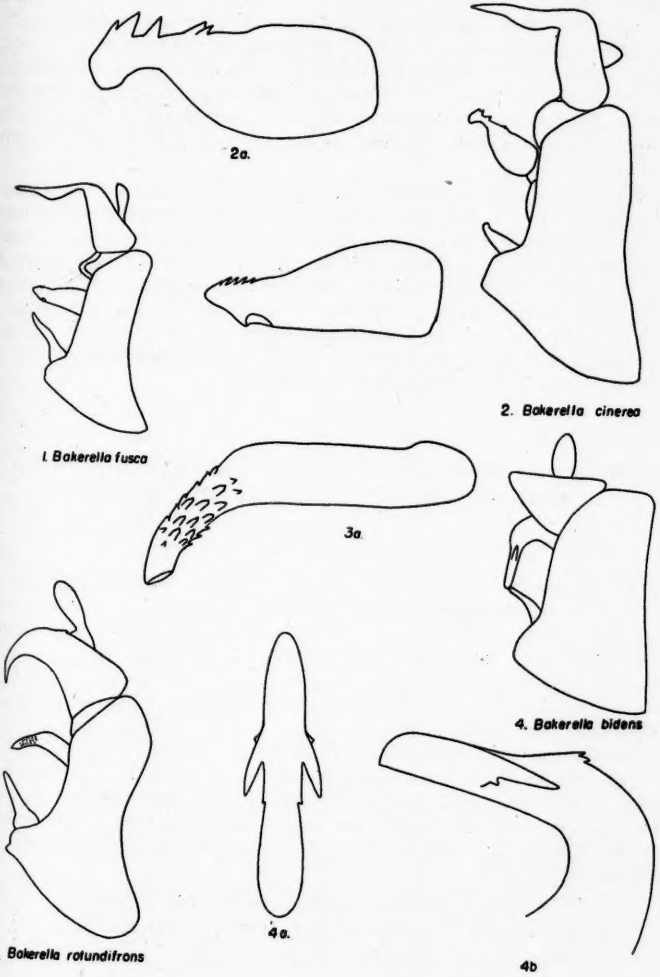
Explanation of Plate

1. Lateral view of male genitalia **Bakerella fusca** n. sp.
1a. Lateral view of aedeagus of **Bakerella fusca** n. sp.
2. Lateral view of male genitalia **Bakerella cinerea** n. sp.
2a. Lateral view of aedeagus of **Bakerella cinerea** n. sp.
3. Lateral view of male genitalia of **Bakerella rotundifrons** n. sp.
3a. Lateral view of aedeagus of **Bakerella rotundifrons** n. sp.
4. Lateral view of male genitalia of **Bakerella bidens** n. sp.
4a. Dorsoventral view of aedeagus of **Bakerella bidens** n. sp.
4b. Lateral view of aedeagus of **Bakerella bidens** n. sp.

angle and anal segment without hooks. Length male 1.75-2.25 mm; female 2-2.5 mm.

Structure: Clypeus and front joined almost on same level, front definitely



widest at middle, about same width at union with clypeus and crown, strongly carinate; crown in male almost square, in female longer than wide, anterior fovea about twice as long as basal width. Elytra of male longer than wide, reaching about to third abdominal segment, apices broadly rounded, veins raised with a few raised, round, scarcely darkened bumps, some of which bear setae. Dorsum of abdomen carinate at middle with semblance of raised bumps on sides of third and fourth segments.

Color: General color ranging from buff to cinereous with most specimens lighter. Front with spots as in **B. cinerea** often absent in lighter specimens. In male, elytra hyaline with apical third fuscous except apical border white, in female, hyaline with two to three apical spots fuscous with apical margin white.

Genitalia: Male styles in lateral view widest at base, tapered to rounded apex, gently curved ventrally; aedeagus in lateral view widest at base, tapered to apex, more suddenly so near outer third, bent ventrally at right angles near middle with a large retrorse spine near apical fourth about as long as width of shaft at this point; anal ring without processes.

Holotype male, allotype female and 81 male and 17 female paratypes, Meade Co., Kansas, Sept. 13, 1944, R. H. Beamer. All specimens were swept from sedges near the big spring at the Meade County State Park.

Types in the Snow Entomological Collections.

THE SWEETPOTATO LEAF BEETLE **TYPOPHORUS VIRIDICYANEUS** (CROTCH) IN KANSAS

H. B. HUNGERFORD
Lawrence, Kansas

In September of this year we received complaints from Oxford, Kansas, of injury to sweetpotatoes by some insect larvae, thought to be the sweetpotato weevil. Mr. L. A. Calkins, assistant entomologist of the Entomological Commission, who investigated the situation, reported that he found considerable injury to sweetpotatoes by some white grub-like larvae which were not those of the sweetpotato weevil. He brought damaged sweetpotatoes to the office and we determined the larvae to be the sweetpotato leaf beetle and this was verified by Doctor W. H. Anderson of Washington, D.C. Since this was our first experience with this insect as a pest in Kansas and since Loyd W. Brannon (1938) in his "The Sweetpotato Leaf Beetle," Circular 495, U.S. Department of Agriculture, does not mention Kansas, the following data taken from specimens in the Frances Huntington Snow Collections may be of interest:

Douglas County, Kansas, 900 feet, L. L. Dyche, 1 specimen.

Douglas County, Kansas, 900 feet, F. H. Snow, 17 specimens.

Lawrence, Kansas, August 4, 1927, W. Benedict, 1 specimen.

Johnson County, Kansas, (June 14), 1915, R. H. Beamer, 2 specimens.

Neosho County, Kansas, 996 feet, R. H. Beamer, 1 specimen.

New Mexico, F. H. Snow, 24 specimens.

Iowa, U.S.A., America Nord, 1 specimen.

Wall, Pennsylvania, August 3, 1926, Chermock, 3 specimens.

The collections by Doctor Snow and Mr. Dyche were made more than fifty years ago and probably considerably earlier than that, while Doctor Beamer got his specimens thirty years ago.

Crotch described the species under the name **Paria viridicyanea** in 1873 and gave as its distribution "Middle and Southern states, Illinois, Mexico." Chittenden, 1925, lists it on sweetpotatoes in North Carolina, South Carolina, Arkansas, Mississippi and Texas. Brannon, 1938, reports records from Maryland, Virginia, Kentucky, Tennessee, Georgia and Alabama. Leng, 1920, in his catalogue, lists Virginia, Florida, Mexico, Indiana and Southern California. Thus the states of Pennsylvania, Iowa, Kansas and New Mexico appear to be new records.

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